

Results of Observations of Shooting Stars, made in the Mediterranean in the years 1869, 1870, and 1871. By Captain G. L. Tupman, Royal Marine Artillery.

In the *Monthly Notices*, vol. xxxiii. page 345, is a paper, by Mr. R. P. Greg, on the Radiant Points and Durations of Shooting Star Showers, which is undoubtedly the most complete and the most accurate that has ever been published. Dr. Heis of Munster, Dr. Julius Schmidt of Athens, Professors Schiaparelli and Zezioli, and others have also, from time to time, published catalogues of radiant points more or less rich; but, with the exception of those of Dr. Schmidt and Prof. Neumayer (in Australia), they contain chiefly the positions of radiants in the northern hemisphere, determined from observations made before midnight.

During three years lately spent cruising in the Mediterranean, I, at the suggestion of Dr. Schmidt, devoted a considerable time to the determination of such radiants as occur between midnight and sunrise, with large north polar distances. The method of observation generally adopted was to keep the equator to the southward in the centre of the sphere of vision, to count the number of shooting stars that appeared during the whole period of observation, to delineate on star-charts as many as possible of the tracks, and to enter in a note-book the time by chronometer, colour, estimated duration, magnitude, &c. In this manner 3800 meteors were observed on 154 mornings free from moon or cloud, the average duration of an observation being a little over two hours. 2000 tracks were registered, and from these the radiant positions were deduced, the other 1800 telling in the horary numbers and richness of streams.

In order to carry out these observations, I found it necessary to construct star-charts on purpose, of fine London board, on which the stars were represented with common ink. No printed charts would bear the continual erasure of the pencil-marks. Since only the equatorial regions were required, I chose the cylindrical projection on a scale of 10° of R.A. to the inch, and inserted all the stars in the Astronomical Society's Catalogue down to the sixth magnitude inclusive, the lines of R.A. and declination being drawn in a colour that was invisible by ordinary lamp-light.

For observations of the great August stream, I used a copy of Plate XI. of the British Association Gnomonic Atlas for 1868. The epoch of the Perseus Radiants is therefore 1850, of the others 1830.

From the necessity of clearing off the tracks every second or third day (and sometimes every day), doubtless many poor streams escaped detection. The complete reduction of such a mass of observations would require more time than I can devote to it, while I think very little would be found to repay the labour. Most of the streams would be a little enriched, a few new ones discovered,

and perhaps a few of the old discarded. Of the 102 radiant
whose positions are given in the Catalogue, 58 are identical, and
21 others are fairly in accordance with those of other observers ;
and as the remaining 23 were found in a precisely similar manner,
and, on the average, by the same number of close meteors, there
is little doubt of nearly the whole of them being true radiant.

The following table shows the disposition of radiant in zones
of north polar distance, according to the largest published lists.
The first is Mr. Greg's list already alluded to, which contains the
British and Italian lists combined ; the second is the list of Dr.
Schmidt from the *Astronomische Nachrichten*, No. 1756,* (the
result of 3000 observations) ; the third is that of Prof. E. Heis, as
published in the B.A. atlas for 1868, and the fourth is my own.

Distribution of the Radiants in Zones of N.P.D.

N.P.D.		Greg.	Schmidt.	Heis.	Tupman.
0° to	30°	25	10	33	6
30° „	60°	67	21	36	23
60° „	90°	34	39	15	42
90° „	120°	7	28	0	31

The results of special observations of the great August stream
are given in an appendix, together with those of other observers,
and the whole are represented on the accompanying chart. Mr.
Greg describes the radiant as an elongated area extending from
Perseus to *Cassiopeia*, the co-ordinates being $\alpha = 50^{\circ}$ to 25° , $\delta =$
 $+ 50^{\circ}$ to 65° , with a special centre at $44^{\circ} + 56^{\circ}$. Professor
Serpieri gives $\alpha = 50^{\circ}$ to 30° , $\delta = + 49^{\circ}$ to 64° , and all observers
agree in a well-defined centre identical with Mr. Greg's.

The branch, or secondary streams do not appear to separate
from the principal according to any law.

I cannot close these remarks without expressing my great ob-
ligations to Mr. Greg for carefully condensing my original
catalogue into nearly its present form, and for having pointed out
most of the agreements with his own and Dr. Schmidt's.

The columns of the catalogue require no other explanation than
that the Zenith Horary Number, where given, has been obtained
by multiplying the number of meteors counted per hour by the
secant of the zenith distance of the radiant. It represents the
number that would probably have been counted by a single
observer with the radiant in his zenith. The numbers in the
general table which follows are, of course, not similarly affected.
It may be mentioned that the *sphere of vision* for small meteors is
about 45° , and for large about 90° in diameter.

* As abridged by Mr. Greg in an MS. copy kindly lent to me.